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Gas Concentration Mapping of Arenal Volcano using AVEMS

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ARENAL VOLCANO, AERIAL FOTO

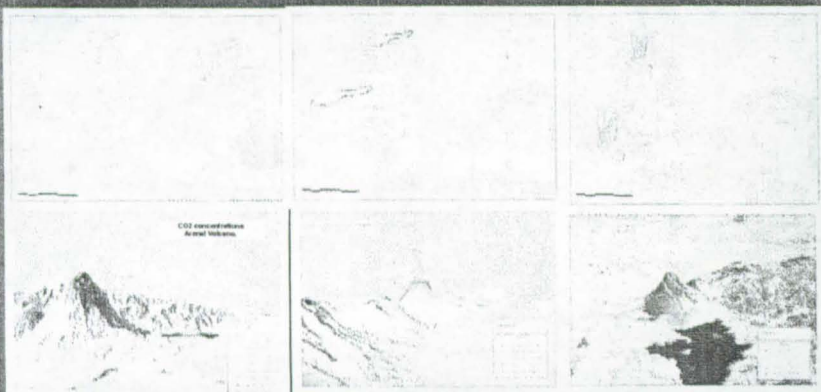
Introduction

The Airborne Volcanic Emissions Mass Spectrometer (AVEMS) System developed by NASA-Kennedy Space Center and deployed in collaboration with the National Center for Advanced Technology (CENAT) and the University of Costa Rica was used for mapping the gas plume of Arenal Volcano, the most active volcano in Costa Rica. The measurements were conducted on the 24th and 25th of March 2005. The CARTA 2005 mission, involving multiple sensors and data collected by three aircraft planes collecting data over the Costa Rican territory, was complemented with ground data with a digital camera, an analog theodolite, a laser altimeter, a multispectral scanner (MASTER) and a hyperspectral scanner. The second aircraft, a King Air 200 from DoE, equipped with a LIDAR sensor, targeted topography mapping and forest density measurements. The third aircraft, a CESSNA Navajo from Costa Rica, integrated with the AVEMS instrument and designed for real-time measurements of air pollutants from both natural and anthropogenic sources, was flown over the volcanoes.

Airborne Volcanic Emission Mass Spectrometer (AVEMS)

System Description:

The improved AVEMS system is designed for deployment via aircraft, car or hand-transport. The 86 pound system employs a 200 Da quadrupole mass analyzer, has a volume of 92,000 cm³, requires 350 W of power at steady state, can operate up to an altitude of 41,000 feet above sea level (-66 C, 50 torr). The system uses on-board gas bottles on site calibration and is capable of monitoring and quantifying up to 16 gases simultaneously. The in-situ gas data in this work, consisting of helium, carbon dioxide, sulfur dioxide and acetone, was acquired in conjunction of GPS data which was plotted with the ground imagery, topography and remote sensing data collected by the other instruments, allowing the 3 dimensional visualization of the volcanic plume at Arenal volcano. The modeling of possible scenarios of Arenal's activity and its direct impact on the surrounding populated areas is now possible with the combined set of data, linking in-situ data with remote sensing data. The study also helps in the understanding of pyroclastic flow behavior in case of a major eruption.



He, CO₂, SO₂ Gas Concentration Maps (above) and 3D Visualization of Volcanic Gaseous Emissions from Arenal Volcano (below) using AVEMS data, LANDSAT multispectral land coverage information and SRTM Digital Elevation Model

ARENAL VOLCANO, 3D Model, CARTA RC-10 photo and SRTM data



KING AIR 2006 the two aircraft used in the AVEMS instrument



AVEMS instrument mounted on the CESSNA Navajo aircraft



AVEMS team during CARTA 2005 Campaign



Map Generation and 3D visualizations:

The gas concentration data collected with AVEMS during the different flights, contains geographical location attributes (Latitude, Longitude, Altitude), obtained using a GPS. These data is the main input to locate spatially the information. In order to model the plume location, which is not necessary visible to the human eye and poorly represented if it is plotted in two dimensions, digital elevation data obtained by other sensors during the CARTA 2005 campaign, topographic data generated by the Shuttle Radar Topographic Mapping (SRTM) Mission and remote sensing data from the LANDSAT satellite (both geo-referenced) are combined to produce a 3D ground model and overlaid with the gas concentration data. In this way, characteristics related to the flight path direction and position of the volcanic plume are visible in the 3D model.



AVEMS team during CARTA 2005 Campaign: PRIAS-CENAT, NASA- KSC researchers and CICANUM-UCR students

Conclusions:

AVEMS demonstrated its usefulness in aerial plume analysis at Arenal Volcano, presently the most active Costa Rican volcano. Several 3D gas concentration visualization were obtained for several gases. These 3D maps now serves to model plume direction and variability to predict possible impact on urban area and crops in the area closer to the volcano, as well as it is used as a guide for aircraft operation near the volcano. Other applications of AVEMS, used during the CARTA 2005 campaign included ground fumarole emission analysis. Also, the concentration of carbon dioxide around urban areas was measured spatially multiple times to provide temporal information as well.

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